Classical dynamics of Josephson vortices

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ABSTRACT

Long Josephson junctions are not only very intriguing systems for studying basic properties of solitons, but also have several useful applications in cryoelectronics. Solitons in Josephson junctions are magnetic flux quanta (also called fluxons, or Josephson vortices) [1, 2]. A vortex can be driven by applying a bias current to the junction. The vortex motion gives rise to a dc voltage across the junction, which can be measured directly in experiment.

In the first lecture I will review recent experiments which demonstrate interesting (classical) dynamics of Josephson vortices. In particular, I will focus on the so called annular Josephson junctions. Due to magnetic flux quantization, annular junction is a topologically closed system in which the number of initially trapped vortices is conserved and new vortices can be created only in the form of vortex-antivortex pairs. I will discuss experimental techniques which can be used to trap vortices in annular junctions [3]. Vortex motion in annular junction can be studied in the most clean way, as it occurs under periodic boundary conditions and without any reflections from boundaries. Recent experiments have demonstrated Cherenkov radiation by vortices moving in multi-layered junctions [4, 5] and in two-dimensional annular structures [6]. In the latter case Cherenkov radiation has a structure similar to the whispering gallery modes.

References

[1] A. Barone and G. Paternó, *Physics and Applications of the Josephson Effect* (Wiley: New York, 1982).

[2] A.V. Ustinov, Physica D **123**, 315 (1998).

[3] A. V. Ustinov. Appl. Phys. Lett. **80**, 3153 (2002).

[4] E. Goldobin, A. Wallraff, N. Thyssen, and A. V. Ustinov, Phys. Rev. B **57**, 130 (1998).

[5] J. Zitzmann, A. V. Ustinov, M. Levitchev, S. Sakai. Phys. Rev. B **66**, 064527 (2002).

[6] A. Wallraff, A. V. Ustinov, V. V. Kurin, I. A. Shereshevsky, and N. K. Vdovicheva, Phys. Rev. Lett. **84**, 151 (2000).